E 1.28: SOLAR/1010-78/11

Aleph. 12148

SOLAR/1010-78/11

Monthly Performance Report

A-FRAME

NOVEMBER 1978

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

MONTHLY PERFORMANCE REPORT

A-FRAME INDUSTRIES

NOVEMBER 1978

I. SYSTEM DESCRIPTION

The A-Frame Industries site is a single-family residence in Kaneohe, Hawaii. Solar energy is used for heating domestic hot water (DHW). The solar energy system has an array of flat-plate collectors with a gross area of 77 square feet. The array faces 10 degrees east of south at an angle of 21 degrees to the horizontal. Potable water is the transfer medium that delivers solar energy from the collector array to storage and to the DHW load. Solar heated water is stored in a 120-gallon DHW tank. Unheated city water is fed directly to the DHW storage tank and supplied, on demand, to the DHW load. When solar energy is insufficient to satisfy the DHW load, an electrical heating element in the storage tank provides auxiliary energy for water heating. The system, shown schematically in Figure 1, has only one mode of solar operation.

Mode 1 - Collector-to-Storage: This mode activates when the temperature of the outlet of the collector exceeds that of the storage tank by 5°F. Water then circulates through the collectors until the temperature difference is 2°F or less.

II. PERFORMANCE EVALUATION

INTRODUCTION

The solar energy system operated continuously during November and satisfied 88 percent of the DHW energy requirements.

WEATHER CONDITIONS

During the month, total incident solar energy on the collector array was 2.4 million Btu for a daily average of 1059 Btu per square foot. This was below the estimated average daily solar radiation for this geographical area during November of 1954 Btu per square foot for a plane facing 10 degrees east of south with a tilt of 21 degrees to the horizontal. The average ambient temperature during November was 73°F as compared with the long-term average for November of 77°F.

THERMAL PERFORMANCE

Collector - The total incident solar radiation on the collector array for the month of November was 2.4 million Btu. During the period the collector loop was operating, the total insolation amounted to 2.1 million Btu. The total

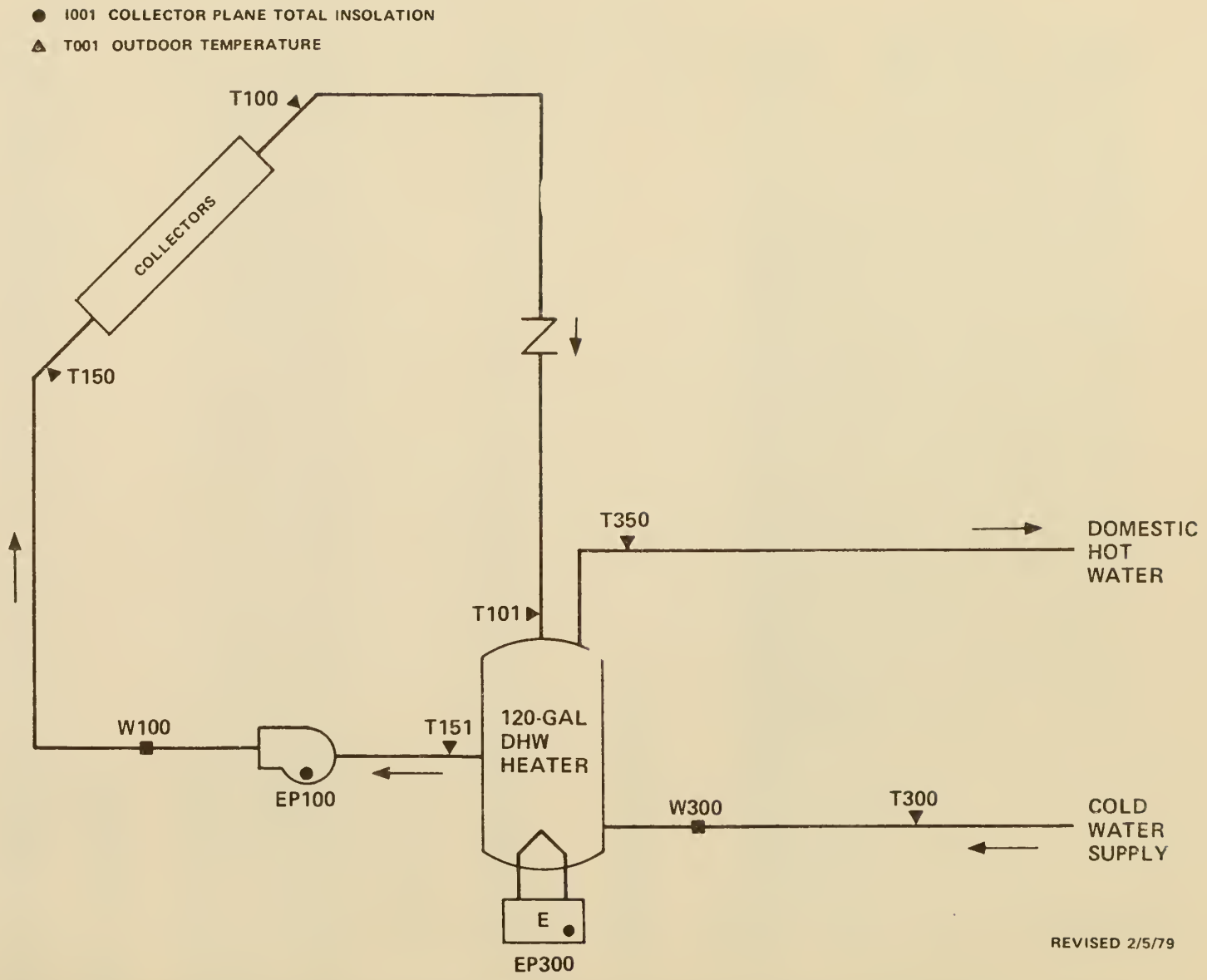

Figure 1. A-FRAME INDUSTRIES SOLAR ENERGY SYSTEM SCHEMATIC

collected solar energy for the month of November was 0.73 million Btu, resulting in a collector array efficiency of 30 percent, based on total incident insolation. Solar energy delivered from the collector array to storage was 0.72 million Btu. Energy loss during transfer from the collector array to storage and loads was 0.014 million Btu. This loss represented 2 percent of the energy collected. Operational energy required by the collector loop was 0.057 million Btu.

DHW Load - The DHW subsystem consumed 0.72 million Btu of solar energy and 0.027 million Btu of auxiliary electrical energy to satisfy a hot water load of 0.70 million Btu. The solar fraction of this load was 88 percent. Losses from the DHW subsystem were 0.29 million Btu. The DHW subsystem required no operational energy, resulting in an electrical energy savings of 0.72 million Btu. A daily average of 56 gallons of DHW was consumed at an average temperature of 120°F delivered from the tank.

OBSERVATIONS

Intermittent data losses due to a telecommunication problem with the site continued throughout November.

ENERGY SAVINGS

The solar energy system provided a net electrical energy savings of 0.66 million Btu. The DHW subsystem provided an electrical energy savings of 0.72 million Btu.

III. ACTION STATUS

IBM and Boeing are planning a site visit to resolve the telecommunication problem.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: A-FRAME
REPORT PERIOD: NOVEMBER,1978

SOLAR/1010-78/11

SITE/SYSTEM DESCRIPTION:
THE A-FRAME SITE IS A SINGLE STORY FAMILY RESIDENCE. THE SOLAR SYSTEM SUPPLIES ENERGY FOR DOMESTIC HOT WATER ONLY, UTILIZING ONE 120 GAL. WATER STORAGE TANK FOR BOTH ECSS STORAGE AND DHW TANK. LIQUID TYPE COLLECTORS ARE USED WITH AN OVERALL AREA OF 77 SQ. FT. AUXILIARY HEAT FOR THE DHW IS PROVIDED BY ELECTRIC HEATER ELEMENTS.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	2.433	MILLION BTU
	31662	BTU/SQ.FT.
COLLECTED SOLAR ENERGY	0.732	MILLION BTU
	9551	BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	73	DEGREES F
AVERAGE BUILDING TEMPERATURE	N.A.	DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.29	
ECSS OPERATING ENERGY	0.057	MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	0.057	MILLION BTU
TOTAL ENERGY CONSUMED	1.058	MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL	
LOAD	0.696	N.A.	N.A.	0.696	MILLION BTU
SOLAR FRACTION	88	N.A.	N.A.	88	PERCENT
SOLAR ENERGY USED	0.718	N.A.	N.A.	0.718	MILLION BTU
OPERATING ENERGY	N.A.	N.A.	N.A.	0.057	MILLION BTU
AUX. THERMAL ENERGY	0.269	N.A.	N.A.	0.269	MILLION BTU
AUX. ELECTRIC FUEL	0.269	N.A.	N.A.	0.269	MILLION BTU
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A.	MILLION BTU
ELECTRICAL SAVINGS	0.718	N.A.	N.A.	0.660	MILLION BTU
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A.	MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.641

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: A-FRAME
REPORT PERIOD: NOVEMBER,1978

SOLAR/1010-78/11

SITE/SYSTEM DESCRIPTION:
THE A-FRAME SITE IS A SINGLE STORY FAMILY RESIDENCE. THE SOLAR SYSTEM SUPPLIES ENERGY FOR DOMESTIC HOT WATER ONLY, UTILIZING ONE 120 GAL. WATER STORAGE TANK FOR BOTH ECSS STORAGE AND DHW TANK. LIQUID TYPE COLLECTORS ARE USED WITH AN OVERALL AREA OF 77 SQ. FT. AUXILIARY HEAT FOR THE DHW IS PROVIDED BY ELECTRIC HEATER ELEMENTS.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	2.567	GIGA JOULES
	360687	KJ/SQ.M.
COLLECTED SOLAR ENERGY	0.772	GIGA JOULES
	108466	KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	23	DEGREES C
AVERAGE BUILDING TEMPERATURE	N.A.	DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.29	
ECSS OPERATING ENERGY	0.060	GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	0.060	GIGA JOULES
TOTAL ENERGY CONSUMED	1.116	GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	0.734	N.A.	N.A.	0.734 GIGA JOULES
SOLAR FRACTION	88	N.A.	N.A.	88 PERCENT
SOLAR ENERGY USED	0.757	N.A.	N.A.	0.757 GIGA JOULES
OPERATING ENERGY	N.A.	N.A.	N.A.	0.060 GIGA JOULES
AUX. THERMAL ENG	0.284	N.A.	N.A.	0.284 GIGA JOULES
AUX. ELECTRIC FUEL	0.284	N.A.	N.A.	0.284 GIGA JOULES
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
ELECTRICAL SAVINGS	0.757	N.A.	N.A.	0.697 GIGA JOULES
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A. GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.641

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: A-FRAME
REPORT PERIOD: NOVEMBER,1978

SCLAR/1010-78/11

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.020	73	0.005	N	0.001	N	0.231
2	0.021	72	0.002	O	0.001	O	0.117
3	0.063	71	0.017	T	0.001	T	0.269
4	0.100	70	0.033		0.002		0.328
5	*	*	*	A	*	A	*
6	*	*	*	P	*	P	*
7	0.092	72	0.023	P	0.002	P	0.251
8	0.144	74	0.044	L	0.003	L	0.302
9	*	*	*	I	*	I	*
10	*	*	*	C	*	C	*
11	*	*	*	A	*	A	*
12	*	*	*	B	*	B	*
13	0.018	72	0.004	L	0.001	L	0.223
14	*	*	*	E	*	E	*
15	*	*	*		*		*
16	0.143	74	0.047		0.003		0.325
17	0.130	73	0.038		0.002		0.289
18	0.049	73	0.018		0.001		0.362
19	0.063	74	0.015		0.002		0.243
20	0.071	75	0.021		0.002		0.295
21	0.110	76	0.031		0.003		0.287
22	*	*	*		*		*
23	*	*	*		*		*
24	*	*	*		*		*
25	*	*	*		*		*
26	*	*	*		*		*
27	*	*	*		*		*
28	*	*	*		*		*
29	*	*	*		*		*
30	0.113	74	0.038		0.002		0.338
SUM	2.433	-	0.718	N.A.	0.057	N.A.	-
AVG	0.081	73	0.024	N.A.	0.002	N.A.	0.295
NBS ID	Q001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: A-FRAME
REPORT PERIOD: NOVEMBER,1978

SOLAR/1010-78/11

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.020	0.010	0.004	75	0.220
2	0.021	0.006	0.002	74	0.088
3	0.063	0.046	0.017	75	0.274
4	0.100	0.089	0.033	75	0.331
5	*	*	*	*	*
6	*	*	*	*	*
7	0.092	0.079	0.024	78	0.264
8	0.144	0.127	0.045	80	0.309
9	*	*	*	*	*
10	*	*	*	*	*
11	*	*	*	*	*
12	*	*	*	*	*
13	0.018	0.009	0.004	*	0.221
14	*	*	*	*	*
15	*	*	*	*	*
16	0.143	0.138	0.048	78	0.332
17	0.130	0.119	0.039	76	0.300
18	0.049	0.040	0.018	*	0.358
19	0.063	0.050	0.016	75	0.246
20	0.071	0.058	0.021	77	0.302
21	0.110	0.097	0.033	78	0.297
22	*	*	*	*	*
23	*	*	*	*	*
24	*	*	*	*	*
25	*	*	*	*	*
26	*	*	*	*	*
27	*	*	*	*	*
28	*	*	*	*	*
29	*	*	*	*	*
30	0.113	0.104	0.039	78	0.343
SUM	2.433	2.082	0.732	-	-
AVG	0.081	0.069	0.024	76	0.301
NBSID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: A-FRAME
REPORT PERIOD: NOVEMBER, 1978

SOLAR/1010-78/11

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.017	5	0.005	N	0.046	0.046	N	0.005	N	69	118	44
2	0.015	81	0.002	O	0.019	0.019	O	0.002	O	72	122	35
3	0.016	100	0.017	T	0.000	0.000	T	0.017	T	72	113	52
4	0.030	100	0.033		0.000	0.000		0.033		71	112	75
5	*	*	*	A	*	*	A	*	A	*	*	*
6	*	*	*	P	*	*	P	*	P	*	*	*
7	0.029	100	0.023	P	0.000	0.000	P	0.023	P	73	129	60
8	0.008	100	0.044	L	0.000	0.000	L	0.044	L	73	126	17
9	*	*	*	I	*	*	I	*	I	*	*	*
10	*	*	*	C	*	*	C	*	C	*	*	*
11	*	*	*	A	*	*	A	*	A	*	*	*
12	*	*	*	B	*	*	B	*	B	*	*	*
13	0.026	87	0.004	L	0.035	0.035	L	0.004	L	72	101	87
14	*	*	*	E	*	*	E	*	E	*	*	*
15	*	*	*		*	*		*		*	*	*
16	0.019	100	0.047		0.000	0.000		0.047		72	116	40
17	0.020	100	0.038		0.000	0.000		0.038		72	135	33
18	0.053	100	0.018		0.000	0.000		0.018		72	136	108
19	0.039	61	0.015		0.025	0.025		0.015		73	117	112
20	0.022	100	0.021		0.000	0.000		0.021		73	118	59
21	0.001	100	0.031		0.000	0.000		0.031		73	114	4
22	*	*	*		*	*		*		*	*	*
23	*	*	*		*	*		*		*	*	*
24	*	*	*		*	*		*		*	*	*
25	*	*	*		*	*		*		*	*	*
26	*	*	*		*	*		*		73	119	*
27	*	*	*		*	*		*		*	*	*
28	*	*	*		*	*		*		*	*	*
29	*	*	*		*	*		*		*	*	*
30	0.029	100	0.038		0.000	0.000		0.038		72	123	56
SUM	0.696	-	0.718	N.A.	0.269	0.269	N.A.	0.718	N.A.	-	-	1673
AVG	0.023	88	0.024	N.A.	0.009	0.009	N.A.	0.024	N.A.	72	120	56
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: A-FRAME
REPORT PERIOD: NOVEMBER, 1978

SOLAR/1010-78/11

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	258	N	73	75	N	N	N
2	270	O	72	74	O	C	O
3	818	T	71	75	T	T	T
4	1311		70	75			
5	*	A	*	*	A	A	A
6	*	P	*	*	P	P	P
7	1195	P	72	78	P	P	P
8	1878	L	74	80	L	L	L
9	*	I	*	*	I	I	I
10	*	C	*	*	C	C	C
11	*	A	*	*	A	A	A
12	*	B	*	*	B	B	B
13	234	L	72	*	L	L	L
14	*	E	*	*	E	E	E
15	*		*	*			
16	1872		74	78			
17	1692		73	76			
18	645		73	*			
19	829		74	75			
20	920		75	77			
21	1432		76	78			
22	*		*	*			
23	*		*	*			
24	*		*	*			
25	*		*	*			
26	*		*	*			
27	*		*	*			
28	*		*	*			
29	*		*	*			
30	1469		74	78			
SUM	31762	N.A.	-	-	-	-	-
AVG	1059	N.A.	73	76	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

*U.S. GOVERNMENT PRINTING OFFICE: 1980-640-189/4170. Region 4.

UNIVERSITY OF FLORIDA
3 1262 05392 7603

UNIVERSITY OF FLORIDA
3 1262 09052 5287